COLLECTION OF EMPIRICAL DATA FOR ASSESSING 800MHz COVERAGE MODELS

Report Number: K-TRAN: KU-03-7

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RESEARCH

Introduction

Wireless communications plays an important role in KDOT operations. Currently, decisions pertaining to KDOT's 800MHz radio system are made on the basis of coverage models that rely on antenna and terrain characteristics to model the coverage. While this technique is well accepted, its effectiveness could be significantly improved if empirical data were available to better calibrate and validate the models.

Project Objective

The University of Kansas was asked to develop and execute a plan for collecting the needed empirical data to better calibrate and validate coverage models.

Project Description

Eight towers were selected by KDOT based on antenna and terrain characteristics to represent a cross section of KDOT's tower array. A passenger car was outfitted with an integrated system to record a received signal strength index (RSSI) value every time period. For each data point, the computer would record the most recent position fix from the GPS receiver (updated about once per second) and would poll the spectrum analyzer for an RSSI value. A route was planned for each tower to provide the best pattern of data point locations. Once the data was collected, it was imported into a geographic information system (GIS). Thematic maps of each tower were generated, showing the RSSI values in graduated colors indicating the strength of the signal. Linear interpolation was used to generate an RSSI surface plot for each tower.

Project Results

Over 6,500 miles were driven, collecting more than 33,000 RSSI values for the 8 towers considered in this effort. The resulting data provides a wealth of drive test data, useful for calibrating the ComStudy propagation model, and is sufficient to show the general size and shape of the coverage area for each tower. Surface plots generated by linearly interpolating the data over a geographic area show the coverage area and potential dead spots. By using this data to improve the existing propagation models, KDOT can obtain a more precise picture of the coverage of their radio system across the entire state, and as a result be able to use these and associated resources more efficiently and effectively.

Report Information

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Wireless communications plays an important role in KDOT operations. Currently used primarily for voice communications, the importance of wireless systems will increase as more systems and devices are deployed that depend on wireless communications. In making decisions related to systems such as these, knowledge of the footprint of the wireless communications coverage is important. Currently, decisions pertaining to KDOT's 800MHz radio system are made on the basis of coverage models that rely on antenna and terrain characteristics to model the coverage. While this technique is well accepted, its effectiveness could be significantly improved if empirical data were available to better calibrate and validate the models. Toward that end, The University of Kansas was asked to develop and execute a plan for collecting the needed data.

Eight towers were selected by KDOT based on antenna and terrain characteristics to represent a cross section of KDOT's tower array. A passenger car was outfitted with an integrated system to record a received signal strength index (RSSI) value every time period. The system included a ruggedized laptop computer mounted in the center of the front seat, a GPS receiver magnetically mounted to the roof of the vehicle and connected to the computer's serial (RS232) port, and a spectrum analyzer set in the center of the rear seat and connected to the computer's parallel port. The *Field Test 4* software package from Survey Technologies, Inc. (STI) was used to control the equipment and collect the data. While the vehicle was moving, one data point was collected every 15 seconds. For each data point, the computer would record the most recent position fix from the GPS receiver (updated about once per second) and would poll the spectrum analyzer for an RSSI value.

A route was planned for each tower to provide the best pattern of data point locations while minimizing the route length. Route planning began by superimposing a square spiral over the tower sight and surrounding road network. A preliminary route was then chosen to approximate the spiral to the extent possible. The extent of the data collection was to exceed the extent of the tower's coverage area. To accomplish this, the spiral was driven outward from the tower until signal strengths showed that the signal from the tower was sufficiently weak to indicate the edge of the coverage area.

The positional accuracy of the data was more than adequate for this application. For all tower sites, less than 1% of the data points used less than six satellites or showed a dilution of precision (DOP) greater than 4. The average DOP values were around 2.0, which suggests sufficient accuracy for this application. An average of about 800 miles were driven for each tower.

Once the data was collected, it was imported into a geographic information system (GIS). Thematic maps of each tower were generated, showing the RSSI values in graduated colors indicating the strength of the signal. Linear interpolation was used to generate an RSSI surface plot for each tower.

The sites were deliberately selected to represent a diverse set of terrain and transceiver characteristics, and the patterns observed in the coverage data were correspondingly diverse from site to site. Consequently, it is difficult to characterize the coverage across all sites. If coverage area is defined as moderately low RSSI values or better, the coverage areas have an average radius of about 20 miles. Because the approach was designed to provide drive test data for propagation model calibration, the surface plots generated from the data should be used with caution. The data points along each highway segment driven are reliable and collected with an approximate linear resolution of about 500 ft to 1500 ft. In the areas between the highway segments driven, many locations are 5 miles or more from the nearest measured data point. Given those distances, the interpolated data must be interpreted as only a rough estimate of the actual coverage. The surface plots provide a picture of the general size and shape of the coverage area, but a more sophisticated propagation model (such as the ComStudy package) should be used if more minute detail is needed.

Over 6,500 miles were driven, collecting more than 33,000 RSSI values for the 8 towers considered in this effort. The use of a spiral route around the tower appears to be an effective technique for collecting a well-distributed data set while allowing flexibility in the size of the driving burden. The resulting data provides a wealth of drive test data, useful for calibrating the ComStudy propagation model, and is sufficient to show the general size and shape of the coverage area for each tower. Surface plots generated by linearly interpolating the data over a geographic area show the coverage area and potential dead spots. By using this data to improve the existing propagation models, KDOT can obtain a more precise picture of the coverage of their radio system across the entire state, and as a result be able to use these and associated resources more efficiently and effectively.

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